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A STUDY OF THE EFFECTS OF MASTITIC MILK
ON THE QUALITY AND YIELD OF CHEESE

by

Clayton Shirl Huber

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Dairy Manufacturing

UTAH STATE UNIVERSITY •
Logan, Utah

1963

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Clayton S. Huber

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INTRODUCTION

Mastitis is found to some degree all over the world where cows are used for milk production. It could be classed as one of the most perplexing problems of milk production in the dairy industry. The loss to the producer and the manufacturer is of considerable importance.

Today sub-clinical mastitis is probably the most common form. This type of infection is commonly so mild that it passes without recognition. It will be investigated in this study.

The influence of mastitis on milk composition has not been studied extensively. Very little research has been done on the influence of mastitic milk when manufactured into various dairy products. In this study, cheddar cheese and cottage cheese will be made from abnormal milk to determine the influence of sub-clinical mastitis.

The terms mastitic and abnormal will be used interchangeably and denote the same meaning.

Objectives

1. Determine the effect of mastitic milk on the yield of cheddar and cottage cheese.
2. Determine the influence of abnormal milk on the quality of cheese, evaluating its effect on the flavor, body, and texture.

REVIEW OF LITERATURE

Mastitis includes any udder infection or abnormality that causes the milk which is secreted to be abnormal in its composition and properties. There are various degrees of severity. In certain instances it occurs in acute or clinical form. The symptoms may include toxemia, increase in body temperature, prostration, loss of appetite, and a highly inflamed and swollen udder from which little or no milk is obtained, it may be bloody and is often lumpy or stringy (Sommer, 1952).

Mastitis may also occur in a sub-clinical form in which the cow and the milk appear to be normal. In the sub-clinical form there is usually variation from time to time in the biological properties and chemical composition. Milk obtained from udders having mastitis have been found to have a higher albumin, sodium and chlorine content, but a lower fat, sugar, phosphate, potassium and calcium content than normal milk (Davis and Mattick, 1936).

Jenness and Patton (1959) point out that the principal effects of mastitis are the lowering of the concentrations of fat, solids-not-fat, lactose and casein. Serum proteins and chloride content are increased. Because of the lower lactose content the osmotic pressure within the udder is decreased. Salts of the blood pass into the milk to offset this deficiency.

Davis and Mattick (1936) listed some of the effects of mastitic milk on the manufacture of cheese. They are:

1. Slow acidity or slow starter
2. Weak curd or poor coagulation
3. Abnormal fermentation in the early stages of ripening
4. Over acidity and faults in texture (openness)
5. Off flavors

Hill (1923) developed a test to determine curd tension. Later Hill and Merrill (1932) upon the basis of this curd test compared cheese made from hard and soft curd milk. The hard curd milk invariably gave a higher yield of cheese. The time required to cook the soft curd milk was greater than for the hard curd milk. Cheese from hard curd milk produced a better body, flavor, and keeping quality.

McDowall et al. (1937) observed that salty milk, characterized by high chlorine content, low lactose content, low acidity and high albumin content and attributed to the presence of inflammation of the udder, produced a soft and unsatisfactory curd. The soft curd milk reached the cutting time twenty minutes later than the hard curd milk and the acidity of the whey at dipping was 0.02 lower than for hard curd milk.

Sommer and Matsen (1934) studied the relation of mastitis to rennet coagulability and curd strength of milk. They determined the strength of the curd utilizing a modified Hill procedure. The average curd strength of milk

from normal quarters was 45.35 grams compared with 23.65 grams for milk from infected quarters. The rennet coagulation time was 9.70 minutes for milk from normal quarters compared with 43.79 minutes for the infected quarters. They concluded that sub-clinical mastitis caused the milk to have a lower curd strength and to coagulate more slowly with rennet.

Monier and Sommer (1932) reported that two samples of milk selected and studied as typical soft curd milk were later found from the veterinarian's record to have shown a history of mastitis during the time the samples were studied. Further work showed that while mastitis was not the sole cause of soft curd milk it did lower the curd strength.

It was observed at the University of Idaho that there was some relationship between mastitis and the production of soft curd milk (Hansen et al., 1934).

Anderson et al. (1936) indicated that soft curd milk was not evidence that such milk is drawn from infected quarters. They compared the curd tension of normal and mastitic milk. A modification of the Hill curd test was used. Milk yielding a curd tension less than 33 grams was soft curd milk; milk from 33 to 60 grams curd tension was medium curd; and milk with a curd tension of more than 60 grams was hard curd. In the Holstein breed 511 cows produced normal milk and had a curd tension of 44.15 grams. The average curd tension of milk from 47 suspicious cows

was 36.00 grams. The number of positive cows was 53 and produced milk having an average curd tension of 35.58 grams. The more positive the milk, the lower was the curd tension. This was consistent for all the breeds tested.

McDowall et al. (1937) stated there are two types of soft curd milk:

1. Individual cows throughout their lives persistently give soft curd milk. Such milk is due to the breed and individuality of the cow and not to any abnormality.

2. Milk of cows which normally give a satisfactory coagulum, suddenly become rennet-resistant.

Anderson et al (1936) discovered a relationship between the number of leucocytes and curd tension. The number of leucocytes in the milk from mastitis-affected quarters of each animal was averaged against the average number of leucocytes in milk from mastitis-free quarters of the same animal. This information is included in the table below.

Relation of curd tension reduction to an increase in leucocyte count

Differences in leucocytes (millions)	Cases (number)	Percentage of cases reduced	Curd tension reduction (grams)
Less than 1	51	57	3.0
1 to 1.9	36	81	7.1
2 to 4.9	23	87	13.3
5 to 9.9	15	80	15.2
10 or more	5	100	30.6

Very little reduction in curd tension was found when the leucocyte count of diseased quarter exceeded the cell count of the mastitis free quarters by less than one million. As the leucocyte count increased from one million to more than 10 million per cc. the curd tension was reduced in direct proportion to the leucocyte count.

Hansen et al. (1934) reported that mastitis caused by a streptococcal infection lowers the curd tension more than mastitis caused by a staphylococcal infection. Anderson et al. (1936), however, found the curd tension of milk was decreased by either streptococcal or staphylococcal infection, and that coli-like mastitis infection decreased the curd tension greater than any of the other reported types of mastitis infections.

Hansen et al. (1934) stated that the concentration of casein is the major factor in determining the curd character of cow's milk and that soft curd milk contains less calcium and phosphorus than hard curd milk. The ratio of calcium to phosphorus is substantially the same regardless of the curd character.

Weisberg et al. (1935) stated that the fat, casein, calcium and phosphorus by means of their concentration and manner of dispersion seem to control the curd character.

Causitive Agents

Several different types of bacteria have been known to cause mastitis. Hammer and Babel (1957) list

Streptococcus agalactiae as the most dominant bacteria causing mastitis. Other organisms they included were Streptococcus equisimilis, Streptococcus uberis, Micrococcus pyogenes var aureus, Pseudomonas aeruginosa, Corynebacterium pyogenes, and coliform types.

Foster and Frazier (1960) pointed out that previously Streptococcus agalactiae had been responsible for most mastitis. The wide-spread use of antibiotics has almost eliminated this organism as the causal agent and the incidence of mastitis caused by Micrococcus pyogenes var aureus has increased.

Nisksch et al. (1960) reported on 3137 milk samples from 582 herds in different areas of the United States in which mastitis had not responded to antibiotic treatment. They found the following organisms to be involved: Staphylococci, 50.9 percent; Streptococci, 25.9 percent; Escherichia coli, 5.9 percent; Corynebacterium, 5.6 percent; Pseudomonas aeruginosa, 1.9 percent; Klebsilla, 1.2 percent; and other possible pathogens 3.5 percent. Martin and Gould (1962) point out that Norcardia and Actinomyces have also caused mastitis.

Theilem et al. (1959) attributed single organism infection to Escherichia coli, Micrococcus pyogenes, Streptococcus agalactiae, Streptococcus dysagalactiae, unidentified Streptococci and coagulase negative micrococci.

California Mastitis Test

The California Mastitis Test was developed by Schalm and co-workers (1957). While this test was developed for use at the side of the cow, it may be used on samples of bulk milk. Two reactions are to be noted--formation of a precipitate or gel and the development of contrasting shades of purple. Bromcresol reveals abnormal alkalinity or acidity of the milk by creating a contrasting color. Bromcresol purple (dibromo-o-cresolsulfonphthalein) in the final concentration is 1:10,000. In developing the test a number of anionic surface agents were used to produce a gel. The particular reaction can be anticipated when milk of high cell count is brought in contact with the sodium or potassium salts of any of the following in the proper concentration: long chain fatty acids, alkyl sulfates, alkyl sulfonates, alkyl arylsulfates, or alkyl arylsulfonates. The reagent ruptures the cells, releasing the cellular protein; the corpuscular proteins are unfolded by the breaking of bonds and these unfolded molecules unite with the reagent causing it to precipitate or gel. As the reaction becomes more pronounced, both the total cell count and the percentage of leucocytes increase.

Carroll and Schalm (1962) reported that deoxyribonuclease (DNA) is the cellular component responsible for positive California Mastitis Test reactions. Deoxyribonuclease (DNA) has its origin mainly in nuclei of cells constituting the inflammatory exudate. They also found that the addition of

DNase to the gel formed by mastitic milk and the California Mastitis Test reagent causes an almost instantaneous breakdown of the gel.

Braund and Schultz (1963) considered a cow's milk positive if one or more of her quarters scored two or three. The physiological factors having the greatest effect on the California Mastitis Test were parity, stage of lactation and the dry period. First lactation animals increased as cows passed mid-lactation. Seventy percent of quarters positive at the end of a lactation returned to negative following a dry period.

Roundy Mastitis Test

The Roundy Mastitis Test is based on an estimation of the activity of the enzyme catalase in milk. Milk normally contains some catalase, which acts as a catalyst in liberating oxygen and water from hydrogen peroxide. Udder infection increases the catalase activity of milk which is caused by material of cellular origin, principally leucocytes.

Spencer and Simon (1960) pointed out that catalase is not present in significant amounts in normal milk and represents one of the very few substances in milk associated with mastitis. They found that the catalase in milk was correlated with high body cell counts and the California Mastitis Test reaction, although the values were not uniformly parallel. For quality control tests on mixed herd

milk, the catalase test is considered superior to the Breed count and the California Mastitis Test (Spencer and Simon, 1960). Braund and Schultz (1963) concluded the catalase test was slightly superior to the California Mastitis Test in detecting milk from positive cows and positive quarters.

Inflammatory exudates derived from the breakdown of body cells from the udder and blood are the likely source of catalase and the reactive substance in the California Mastitis Test.

Leucocyte Count

Many workers have studied the problem of leucocytes in milk, and they agree that there will be some leucocytes in the milk of any cow. How large or small this number is may be considered as an index of either health or infection. No definite numerical standard has been recommended or agreed upon as a positive diagnostic criterion for mastitis.

Sommer (1952) recommended that the leucocytes be counted in at least ten fields, and the results expressed as leucocytes per cc. According to Sommer (1952) recent investigators have regarded counts above 500,000 per cc. as indicative of mastitis.

The work performed by Cherrington et al. (1953) revealed that the leucocyte content of milk from both normal and diseased quarters shows wide variations. Milk from infected quarters had a much higher leucocyte content than milk from

normal quarters. They found the average leucocyte count of milk from six normal cows to be 43,000 per cc., whereas the count on milk from several diseased cows was 3,000,000 per cc.

If the percentage of infected animals within a herd is 40 percent or more, the average leucocyte count of the herd milk may be 1,000,000 or more leucocytes per milliliter of milk (MacLeod et al., 1953).

Baker and Breed (1920) found a close relationship to exist between decreasing hydrogen-ion concentration of the fresh milk and an abnormal number of leucocytes. They attribute the decreasing hydrogen-ion concentration to the entrance of the alkaline substances of the blood into the milk.

PROCEDURE

Procurement of Milk

The milk utilized in this study was collected from Grade A dairy farms located in the vicinity of Logan, Utah. Milk abnormal in appearance was not used. Milk was collected only from cows having sub-clinical mastitis. All milk obtained was being used daily for Grade A purposes. The fat content of the raw whole milk was determined by the Babcock method as described by the Association of Official Agricultural Chemists (1960).

Tests Used to Indicate Abnormal Milk

The California Mastitis Test (Schalm and Noorlander, 1957) was employed to identify normal and abnormal milk at the cow. A sample of fore-milk was collected from each quarter. An equal amount of reagent was added to the milk. The reaction of the test was determined using five different classifications: negative, trace, one, two, and three. Milk that produced a trace reaction in one quarter or less with the other three quarters being negative was collected as normal milk. Milk from two or more quarters that produced a two or three reaction was collected as abnormal milk in the first two trials. In the remaining comparisons, all four quarters produced a number two reaction or more.

Milk from cows yielding normal milk was collected

separately and the milk from such cows was later mixed together. A similar procedure was used in collecting abnormal milk.

Two separate lots of mixed milk, normal and abnormal, were collected for each comparison.

The California Mastitis Test, Roundy's Mastitis Test, and the Leucocyte Count were conducted on each individual vat of mixed milk.

The Leucocyte Count was determined on each lot as indicated by the Standard Methods for the Examination of Dairy Products (1953) with the modification that Wright's Stain¹ was used. If the leucocytes were numerous, ten fields were counted; otherwise, twenty fields were observed. The number of leucocytes was recorded as leucocytes per milliliter.

The following procedure was used for the Roundy Mastitis Test:

1. Both lots of milk were mixed well and a sample was taken for analysis.
2. A dipper full of milk (10 ml) from each lot was placed into each of five test tubes.
3. The test tubes containing the milk were placed in a 95 F (+ 2 degrees) water bath.

¹Wright's Stain is prepared by adding methylene blue in the proportion of 1 gram of dye to 100 cc. of a 0.5 percent aqueous solution of sodium bicarbonate. To each 100 cc. of this solution 500 cc. of a 0.1 percent aqueous solution of eosin is added.

4. The eye-dropper was filled with solution A² and 1 drop was added to tube one, 2 drops to tube two, 3 drops to tube three and so on up to, and including, tube five. The samples were mixed thoroughly by shaking.

5. The samples were held at 95 F (\pm 2 degrees) for two hours in a covered water bath.

6. After the two hour holding period, 6 drops of solution B³ were added to each tube of milk and mixed thoroughly.

7. After 5 minutes the color was observed. A white color of milk in tubes containing 3 or more drops of solution A indicates abnormal milk.

Cheddar Cheese

Treatment of the milk

The two separate lots of milk were then vat pasteurized at a temperature of 143 F with a holding period of thirty minutes.

Cheese manufacture

Two 100 gallon stainless steel vats were used for the manufacturing comparison. The "clock method" (Wilson et al., 1951) for the manufacture of cheddar cheese was followed

²Solution A contains 2 percent hydrogen peroxide obtained from Z. D. Roundy, Madison 5, Wisconsin.

³Solution B contained potassium iodide and starch and was obtained from Z. D. Roundy, Madison 5, Wisconsin.

precisely. The key time intervals are $2\frac{1}{4}$ hours from setting to dipping and $2\frac{1}{4}$ hours from dipping to milling.

The milk was inoculated at 88 F with a 1 percent starter using two stains of Streptococcus lactis and set with 90 milliliters of rennet per thousand pounds of milk.

The weight of the respective lots of cheese was determined when placed in storage.

Examination

The cheese was judged by experienced judges and scored, using the official A.D.S.A. cheese score card, after twenty days. Each lot of cheese was graded at 65 F and the flavor, body, and texture was evaluated.

Analysis

Samples for analysis were obtained from each lot when twenty days old.

The samples were wrapped in aluminum foil and placed in a small, air-tight stoppered container. Analysis of the samples were completed the same day that they were extracted from the cheese.

The moisture content of the cheese was assayed on each lot of cheese. The fat content of the cheese was determined by the modified Babcock Test. The pH of the finished cheese was measured with a Beckman Zeromatic pH Meter. The samples were prepared for pH readings by grinding them with a mortar and pestle until they were pasty in consistency.

Cottage Cheese

Selection and treatment

Milk obtained for the manufacture of cottage cheese was selected on the same basis as the milk used for cheddar cheese. The milk was separated and the resulting skim milk was pasteurized at a temperature of 143 F for thirty minutes.

Cheese manufacture

Two 100 gallon stainless steel vats were used for the different lots of skim milk. The Short Method⁴ was used as a guide in manufacturing the cheese. This included the following steps:

1. The skim milk was set with $5\frac{1}{2}$ percent active starter at 88 F, and $1\frac{1}{2}$ cc. rennet per 1000 pounds of skim milk.
2. The curd was cut when the whey had reached a pH of 4.7 and 15 minutes passed before the curd was stirred.
3. Approximately four inches (measured by depth in the vat) of 120 F water was added in adjusting the temperature.
4. The temperature was raised to 100 F in one-half hour.
5. In the next half hour the temperature of cooking was raised to 120 F.

⁴This procedure is used at Utah State University, Logan, Utah

6. The cooking temperature was raised to 135 F in 15 minutes and held at that temperature for an additional 15 minutes.

7. After the whey was removed, the curd was washed with water having a temperature of 85 F. Immediately after the first washing, the curd was washed with 40 F water.

Examination and analysis

The whey was allowed to drain from the curd for twenty-four hours. Each lot was weighed before the dressing was added. After creaming, the cottage cheese was judged by experienced judges and scored, using the official A.D.S.A. score card. Each lot was evaluated for flavor, appearance and body and texture. The pH was determined on the finished product.

RESULTS AND DISCUSSION

Differences in Yield

Six different lots of cheddar cheese were compared. In each comparison there was a definite decrease in yield of the cheese made from abnormal milk. The decrease in yield of the cheese made from abnormal milk. The decrease in yield ranged from .271 to .949 pounds per 100 pounds of milk. The yield of each lot was compared (Table 1).

Table 1. Comparison of normal and mastitic cheese yield per 100 pounds of milk

Normal X_1	Mastitic X_2	Difference $X_1 - X_2$
9.663	9.053	.610
9.673	9.359	.314
11.149	10.878	.271
10.046	9.763	.283
10.027	9.078	.949
10.252	9.843	.409

$$H_0:U_D = 0$$

$$d = .4727$$

$$t = 4.37685 \text{ with } 5 \text{ d.f.}^{**}$$

Using the Student's "t test," the difference in yield was significant at the .01 level. The 99 percent confidence interval for the population mean difference was

.0372 < U_D < .9082. The average mean difference was .4727.

This difference in yield may be caused by the decreased casein and S.N.F. content of mastitic milk or the loss of these constituents in the whey at dipping. This needs further investigation. This loss may be related to the higher sodium and the lower calcium content of abnormal milk. The sodium could unite with the casein forming a softer curd and also increase the solubility of the casein. The character of the curd is definitely affected.

Scoring of the Cheese

After a twenty-day ripening period each lot of cheddar cheese was examined and scored. In each comparison cheese made from mastitic milk received a lower total score and grade (Table 2). The difference in quality is important. At the present time the price of A grade cheddar cheese in Salt Lake City, Utah, is \$0.42 per pound. B grade is \$0.02 less per pound, and C grade is \$0.04 less per pound than A grade cheese. Additional study should be done to determine the effect of varying quantities of mastitic milk when added to normal milk and its effect on the grade of cheese.

The lower scores of both samples in lot five can be attributed to contamination. This defect was much more prevalent in the mastitic sample.

There was quite a pronounced effect on the body and texture of cheese made from mastitic milk (Table 3).

Table 2. Total score and grade of cheese manufactured from normal and mastitic milk

Lot No.	Normal		Mastitic		Difference in score	Difference in grade
	Grade	Score	Grade	Score		
1	A	94.0	B	91.0	3.0	1
2	A	93.0	B	91.0	2.0	1
3	A	94.5	B	91.0	3.5	1
4	AA	95.0	C	89.5	5.5	2
5	B	91.0	C	88.5	3.0	1
6	A	94.5	C	90.5	4.0	2

Table 3. Body and texture defects of normal and mastitic cheese

Lot No.	Normal		Mastitic	
	Score	Comments	Score	Comments
1	29	open	29	mealy and open
2	29	open	28	pasty
3	30	--	28	pasty & gassy
4	30	--	27.5	pasty and open
5	28	open & sl. gassy	26	pasty & gassy
6	29.5	sl. open	27.5	pasty, gassy, open

The pasty defect existed in all the mastitic samples but lot one. This defect is probably due to the lower curd tension or the character of the casein of the mastitic milk.

A fermented flavor was observed in each sample of cheese made from milk which was abnormal (Table 4).

Tests Used to Determine Quality

The California Mastitis Test, the Roundy Mastitis Test and the Leucocyte Count corresponded closely in detecting milk that was normal and abnormal (Table 5).

The leucocyte count for mastitic milk ranged from 2,264,000 to 3,996,000 per milliliter. The leucocyte count for the normal milk ranged from 66,000 to 399,000 per milliliter.

The California Mastitis Test produced a number two reaction for the mixed mastitic milk in all six lots. All lots of the mixed normal milk were free from mastitis.

All samples of abnormal milk exhibited a positive reaction with the Roundy Mastitis Test. Milk producing a white color with three or more drops of Solution A indicates mastitic milk. All lots of normal milk resulted in a color change with less than two drops of Solution A.

Observations During Manufacturing

The titratable acidity was measured on each vat of milk before the addition of the starter culture. The

Table 4. Flavor criticism of normal and mastitic cheese

Lot No.	Normal		Mastitic	
	Score	Comments	Score	Comments
1	40.0	----	38.0	sl. high acid, fermented
2	39.0	sl. high acid	38.0	sl. high acid, fermented
3	39.5	sl. high acid	38.0	sl. high acid, fermented
4	40.0	----	37.0	sl. high acid, fermented
5	38.5	sl. high acid	37.5	fermented
6	40.0	----	38.0	fermented

Table 5. Comparison of Leucocyte Count, California Mastitis Test and Roundy Mastitis Test on mixed milk

Lot No.	Leucocyte	California Mastitis Test	Roundy Mastitis Test ^a
1 (Normal)	--	negative	0
1 (Mastitic)	--	2	3
2 (Normal)	166,000	negative	1
2 (Mastitic)	2,264,000	2	3
3 (Normal)	399,000	trace	2
3 (Mastitic)	3,966,000	2	5
4 (Normal)	99,000	negative	0
4 (Mastitic)	3,463,000	2	5
5 (Normal)	199,000	negative	0
5 (Mastitic)	3,966,000	2	4
6 (Normal)	66,000	negative	0
6 (Mastitic)	3,729,000	2	4

^aDrops of Solution A that resulted in a white color.

titratable acidity of the mastitic milk was always less than normal milk (Table 6).

Table 6. Titratable acidity of normal and mastitic milk

Lot No.	Normal	Mastitic
1	.16	.15
2	.16	.15
3	.16	.15
4	.16	.13
5	.18	.13
6	.17	.13

In each trial the abnormal milk produced a soft and fragile curd at cutting. This observation was also noted by Davis and Mattick (1936).

The abnormal curd lacked the cohesive character that the normal curd possessed during the earlier period of cheddaring. At milling the mastitis curd had a much softer body. The abnormal vat had a titratable acidity greater or equal to the normal vat at milling in five of the six comparisons.

Analysis of Cheese

The treatment and analysis of each lot of cheese is included in Table 7.

In all trials but number one and number three the

Table 7. Treatment and analysis of each vat of cheese

Lot No.	Percent fat in milk	Temperature cooking F.	Milling acidity	Percent moisture	Percent fat	pH after 20 days
1 (Normal)	3.30	101°	.34	40.2	28.5	5.1
1 (Mastitic)	3.30	101°	.42	39.5	28.5	5.15
2 (Normal)	3.20	101°	.43	41.4	28.5	5.2
2 (Mastitic)	3.20	101°	.48	42.3	29.0	5.25
3 (Normal)	3.70	102°	.475	41.8	29.0	5.0
3 (Mastitic)	3.70	102°	.51	41.6	29.0	5.15
4 (Normal)	3.65	101°	.46	38.8	34.0	5.15
4 (Mastitic)	3.40	101°	.46	42.4	30.5	5.1
5 (Normal)	3.60	101°	.55	39.6	33.5	5.15
5 (Mastitic)	3.40	101°	.44	41.4	29.5	5.3
6 (Normal)	3.65	102°	.30	39.2	34.5	5.1
6 (Mastitic)	3.40	102°	.30	42.2	29.5	5.15

moisture content of the mastitic cheese was higher than the cheese made from normal milk. In both of these lots there was very little difference in the moisture content.

The fat content was higher for normal cheese in five of the six lots. The normal milk in lots four, five, and six had a higher fat content. The fat content of the whey was determined on each comparison. The amount of fat in the whey of the abnormal lots ranged from .06 percent to .35 percent. The fat content of whey from normal lots ranged from .06 percent to .26 percent.

The pH was determined after the twenty-day ripening period. The mastitic cheese produced a higher pH in five out of six comparisons.

Staphylococcus pyogenes var. aureus may survive pasteurization. This bacteria is now responsible for many cases of mastitis. Further study could be conducted to determine the presence of Staphylococcus pyogenes var. aureus or toxins in cheese made from mastitic milk and its relation to food poisoning.

Cottage Cheese

The influence of mastitic milk on cottage cheese was studied. Two comparisons were made between normal and mastitic milk. A decrease in yield was noted in both lots made from mastitic milk. The average difference in yield per 100 pounds of skim milk was .527 pounds. Whey from the abnormal vat contained more curd dust and would be a

contributing factor for the decreased yield.

The quality of the cottage cheese was affected by abnormal milk. The total score for the abnormal lots was 89 and 87 and the score of the normal lots was 91 and 90 respectively. Cottage cheese from the abnormal vats had a slightly buff or unnatural appearance.

The pH was determined after application of the dressing. This is usually an indication of the shelf-life. Cheese from normal lots had a slightly lower pH.

Samples for pH determination were taken each hour from setting until cutting. Samples were obtained from the bottom of the vats and the surface. Neither the normal or the abnormal vats showed any difference in pH at the various depths. The mastitic samples always produced a softer and weaker curd at cutting even though the curd from all lots was cut at pH of 4.7. The titratable acidity was lower for the normal vats.

SUMMARY AND CONCLUSIONS

Summary

The California Mastitis Test, the Roundy Mastitis Test and the Leucocyte Count were used to indicate normal and mastitic milk.

Upon the basis of these tests, six lots of normal and mastitic milk were manufactured into cheddar cheese. Mastitic milk resulted in a definite decrease in cheese yield. This decrease in yield ranged from .271 to .949 pounds per 100 pounds of milk. There was a significant difference at the .01 level.

The six lots made from normal milk had an average yield of 10.1316 pounds per 100 pounds of milk. Using this as a standard cheese yield, the percent loss of cheese in this experiment would be 4.67.

It was reported recently that 30 percent of the milk received at a local cheese plant was mastitic according to the California and Roundy Mastitis Tests. If 10,000 pounds of milk was manufactured into cheddar cheese, this percentage of mastitic milk may decrease the yield 14,000 pounds. This would amount to \$5.88 per vat if sold at \$.42 per pound.

The total score of the abnormal cheese was less compared with the normal vat. A difference of at least one grade was noted with each comparison. A grade reduction of cheese

manufactured from the type and quantity of milk discussed in the previous paragraph would amount to \$20.26 per vat.

Mastitic milk had a pronounced effect on the flavor, body, and texture of the cheese. The common flavor criticism of cheese made from mastitic milk was "fermented." The characteristic body and texture defect of the mastitic cheese was described as weak or pasty.

Mastitic milk also decreased the yield of cottage cheese. The average difference in the yield from the two lots was .527 pounds per 100 pounds of skim milk. Cottage cheese made from abnormal milk resulted in a lower total score.

Conclusions

1. Mastitic milk decreased the quality or score of cottage cheese. It had an effect on the color and appearance.
2. Milk from cows having sub-clinical mastitis reduced the yield of cheddar and cottage cheese.
3. Mastitic milk reduced the quality of cheddar cheese. A pronounced effect on flavor, body and texture was observed.
4. The influence of mastitic milk on yields and grade of cheddar cheese may cause a very significant loss in the commercial cheese plant.

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